NONTOXIC CORROSION INHIBITORS FOR COPPER IN SULPHURIC ACID

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Because of its excellent thermal conductivity and good mechanical workability, copper is a material commonly used in heating and cooling systems. Scale and corrosion products have a negative effect on heat transfer, and they cause a decrease in heating efficiency of the equipment, which is why periodic descaling and cleaning in sulphuric acid (or hydrochloric acid) pickling solutions are necessary. Corrosion inhibitors effectively eliminate the undesirable destructive effect and prevent metal dissolution. Most of commercial pickling inhibitors are toxic compounds and should be replaced with new environmentally friendly inhibitors.

This paper focuses on the efficiency of nontoxic imidazole derivatives as copper corrosion inhibitors in sulphuric acid. Imidazoles are organic compounds with two nitrogen atoms in the heterocyclic ring. One of the nitrogen atoms is of pyrrole type, and the other is a pyridine-like nitrogen atom. The imidazole molecule shows two anchoring sites suitable for surface bonding: the nitrogen atom with its lonely sp^2 electron pair and the aromatic ring. Imidazole is known for strong adsorption on gold, copper and silver.

The influence of the structure and composition of homologous series of imidazole derivatives on the inhibiting efficiency of copper corrosion in sulphuric acid was studied using electrochemical methods and gravimetric method. Some of the investigated compounds are secondary products in pharmaceutical industry and some of them are specially synthesized for this investigation.

The results of the investigation show that all investigated imidazole derivatives have fairly good inhibiting properties for copper corrosion in sulphuric acid. The introduction of functional groups to imidazole ring improved the inhibiting properties. The best protection (93%) was obtained by adding a phenyl ring to the imidazole structure.

The values of standard free energies of adsorption, as calculated from the Freundlich isotherm, indicate that in the presence of sulphuric acid as well as in hydrochloric acid imidazole derivatives adsorb on copper by physisorption-based mechanism. This is also supported by the fact that the higher molecular weight imidazole derivatives show better corrosion inhibition. The exception is 1-phenil-4-methylimidazole in sulphuric acid which is (unlike in hydrochloric acid) better inhibitor for copper corrosion than 1-(p-tolyl)-4-methylimidazole.

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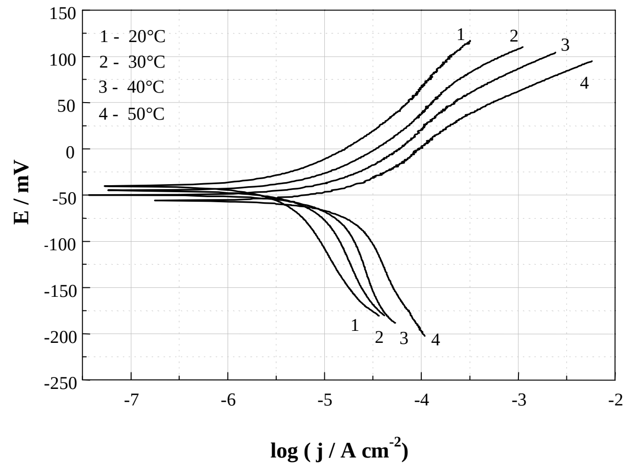

Fig. 1. Anodic and cathodic polarization curves for copper in 0.5 M H_2SO_4 with the addition of 1-phenyl-4-methylimidazole at different temperatures.

Temperature 20°C					
Solution	E_{corr} mV	b_a mV/dec	$-b_c$ mV/dec	j_{corr} μAcm^{-2}	z %
0.5M H_2SO_4	-11	49	1004	78.58	-
Inh 1	-15	47	447	35.05	55
Inh 2	-38	65	517	27.10	65
Inh 3	-40	68	174	5.80	93
Inh 4	8	68	157	9.03	88
Temperature 30°C					
Solution	E_{corr} mV	b_a mV/dec	$-b_c$ mV/dec	j_{corr} μAcm^{-2}	z %
0.5M H_2SO_4	-8	42	340	128.40	-
Inh 1	-19	52	289	46.63	63
Inh 2	-33	64	639	43.80	66
Inh 3	-45	73	225	11.67	91
Inh 4	-3	71	183	11.70	89
Temperature 40°C					
Solution	E_{corr} mV	b_a mV/dec	$-b_c$ mV/dec	j_{corr} μAcm^{-2}	z %
0.5M H_2SO_4	-1	42	463	176.00	-
Inh 1	-25	56	319	72.56	58
Inh 2	-31	68	687	63.40	64
Inh 3	-50	75	282	19.60	89
Inh 4	-11	74	341	25.78	85
Temperature 50°C					
Solution	E_{corr} mV	b_a mV/dec	$-b_c$ mV/dec	j_{corr} μAcm^{-2}	z %
0.5M H_2SO_4	-4	47	870	255.60	-
Inh 1	-19	43	218	138.10	46
Inh 2	-19	60	352	81.60	68
Inh 3	-56	84	240	33.80	87
Inh 4	-25	96	395	57.68	77

Inh 1 – imidazole
Inh 2 – 4-methy-5-hydroxymethylimidazole
Inh 3 – 1-phenyl-4-methylimidazole
Inh 4 – 1-(p-tolyl)-4-methylimidazole

Table I. Corrosion parameters for copper in 0.5 M H_2SO_4 without and with addition of inhibitors at different temperatures obtained by Tafel extrapolation method